



National Levee Database Survey Standard

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Prepared For
United States Army Corps of Engineers

Prepared By
National Levee Database Program

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Version History

Revision Note

This survey standard focuses on key data requirements for levee infrastructure that will be entered into the National Levee Database.

Date	Version	Principal Author	Comments
6/30/2007	1.0	CRREL	Initial Draft guidance provided to Districts. Districts tailored survey specifications locally.
1/24/2015	2.0	NLD Program	Revised standard based on lessons learned of surveys conducted 2008-2011
6/26/2015	3.0	NLD Program	Revised based comments from districts

1.0 Purpose

The National Levee Database (NLD) survey standard defines the minimum positional data and supporting inventory levee infrastructure collection standards for levee infrastructure within the U.S. Army Corps of Engineers (USACE) programs. The goal is to collecting accurate horizontal, vertical and supporting data on levee features to this standard and populating a database with the collected information.

The overall objective is to develop a standardized geospatial NLD structured data deliverable including all necessary attributes of levees and floodwalls relevant to design, construction, operations, maintenance, repair, inspections, and potential for failure. This database consists of mandatory feature classes and fields that must be populated, as well as optional fields that are specific to the management practices of specific communities of practice, users, and operators. The database structure is the same at every District to assure commonality of USACE levee data. This document summarizes a basic levee survey plan for any USACE program levees to be submitted to the NLD including any previously documented levees requiring an accuracy upgrade to meet this standard.

2.0 Process

A simple process should be followed to gather, format and enter new levee information into the NLD for levees that are in the USACE managed programs. A process for gathering initial infrastructure information for new levees would include:

- Data Preparation: Download data model format data containers for input.
- Data Discovery: Assemble existing levee documentation.
- Survey: Ground survey levee features.
- Populate geodatabase with spatial and non-spatial information from survey and data discovery materials.
- Upload geodatabase to the NLD.

Sections 3-8 describes the steps of the process to gather pertinent spatial and non-spatial levee information and populate the database container that will be eventually uploaded into the NLD.

3.0 Data Preparation (Data Model)

Geospatial data collected in support of the levee safety program shall comply with the most current NLD data model implementation and data dictionary definitions. The current NLD data model, dictionary and instructions for submitting can be downloaded at <https://maps.crrel.usace.army.mil/nldp/f?p=299:1:1915153346989:::> under the help menu on the website. This website requires an account to login and retrieve or post data or documentation. Users should contact the NLD help desk for an account using the methods listed under the "Contact Us" tab of the website.

4.0 Data Discovery (pre-survey)

The levee data proponent shall assemble all relevant background materials required to populate the attribute fields of the current NLD data model acquired in section 3. Relevant materials would include: Operations and Maintenance Manuals, Inspection of Completed Works (ICW) documents, Project drawings, as-builts, permit documents, design memorandums, inspection reports, or any other construction, design, inspection or maintenance documentation. This information can be used to derive attribution for the collected feature classes listed in Section 6. Levee data managers are highly encouraged to populate as much data as possible using the aforementioned source material and within time and budget constraints.

5.0 Mandatory Data Structure Elements and Business Rules

A subset of required data elements in the current data model must be populated to submit levee data to the NLD. The following required data elements and rules must be followed to complete a NLD data submission:

Data Model - Validate database to ensure all tables exist and relationships are correct since the geodatabase does not maintain foreign keys

- Verify each submission is a valid database with proper parent/child relationships, verification of data types, etc.
- Unique Key constraints (verification that all unique columns are unique)
- Foreign Key constraints (verification that all foreign key references are correct)
- Not Null Constraints (columns that cannot have a null value if a record appears in that table)

Geospatial - Verify GIS data is accurate 3-D geometries captured in appropriate projections

- All shapes are valid 3-D geometries, M-values should also be enabled
- All shapes are in the correct projection (GCS NAD 83)

Business Rules - Verify all necessary records are filled out completely

- Each System must have a Segment
- Each System must have a leveed area
- Each Segment must belong to a System
- Each Segment must have an authorization type
- Each Segment must map to at least one Sponsor/Organization
- Each Segment must map to at least one Authorization
- Each Authorization must be given a project type
- Each segment must provide a RIP Status
- All key lengths must be 10-digit integers

Additional levee infrastructure attribution in the data model can be populated using the source materials referenced in Section 4. The NLD data submission does not require the data elements beyond those listed above in this section to pass validation. Data managers are highly encouraged to populate as much data as possible within time and funding constraints

6.0 Ground Survey and Mapping Requirements

In order to capture accurate spatial representations of the levee infrastructure a ground survey should be conducted to capture high accuracy horizontal and vertical data for the levee features. Feature should be collected to accuracy standards listed in section 6.1.

Initial spatial data should be gathered for the following features (if applicable):

- Levee/floodwall centerline
- Closure structures
- Cross sections
- Gravity drain
- Pump stations
- Levee crossings

Additional features and data are gathered during separate follow-on levee safety processes for example routine or periodic inspections. The additional features and data will be captured as part of those business processes.

6.1 Datums, Projections, Accuracy and Units

All positional data will be in geographic coordinates (decimal degrees recorded to 7 decimal places) and referenced to North American Datum of 1983 (NAD83). The control network established under this task shall be properly connected to National Spatial Reference System (NSRS) control points with established network accuracy values. Continuously operating reference station (CORS) data shall be incorporated into all Global Positioning System (GPS) network computations. Positional accuracy (x and y) for control points established under this task order must meet or exceed NSSDA Class 1(1:240) both horizontally and vertically (z) value. This equates to an accuracy of 0.2 feet at the 95% confidence level.

All vertical elevations shall be referenced to North American Vertical Datum 1988 (NAVD88). Ellipsoid heights acquired by GPS should be converted to NAVD88 using GEIOD12A. Guidance stated in the Comprehensive Evaluation of Project Datums (CPED) circular, USACE EC 1110-2-6065, shall also be followed for all vertical datum use and application. In all cases where GPS is used, the full 3D ellipsoid designation and geoid name should be noted in the “Supplemental Section” of the metadata. All linear units not otherwise annotated, including elevations, will be in US Survey feet.

6.2 Levee Data Collection Procedure

The ground survey should gather the following minimally required features if they are present. The NLD data model contains additional feature classes which can be accomplished as follow-on tasks to the initial survey.

6.2.1. Establish the location and survey profiles along the center lines of the existing flood control works and all associated structures (closure structures, floodwalls, etc). Including the profiles along the existing centerline tops of levees/embankments and associated structures from two-hundred feet before the beginning and two-hundred feet past the end, or as far as possible given conditions on the ground. The start and end of any of the three feature types shall be taken even if connected. Collect photos of features where applicable, i.e. closure ends, etc. (levee_centerline, floodwall_line, closure_structure_line)

6.2.2. Levee profile elevations and locations shall be obtained at 75 ft intervals along all levees, flood walls, and closure structures. Additional profile shots shall be taken where significant grade changes in profile occur along the centerline. A nominal precision of 0.2 ft or better is required. The profiles shall clearly show the gaps and lowered crown areas and any raised areas which are the result of excavation, erosion, crossings, subsidence, consolidation, or fill activities as well as turns in levee alignment. All of the control points recovered at a surveyed site shall be provided and be plotted at the appropriate coordinate point on a planimetric or a topographic map to provide an overall control diagram of the entire project.

6.2.3. Obtain typical cross sections of the levees at approximately two thousand (2,000) foot intervals, or as indicated on provided maps. The levee sponsor or servicing district will provide the maps for reference. Cross sections shall be surveyed from the centerline to typical terrain on the landside and to typical terrain past the toe on the waterside. Waterside sections should go to the high bank whenever the high bank is within approximately 200 feet of the riverside toe, with a minimum of seven shots per section (crown center and edges, toes, land and riverside natural ground). It is not anticipated that surveys will be conducted during periods of high water and use of a boat to obtain any additional elevations in the water will not be necessary. (cross_section_line)

6.2.4. Provide location, station, if readily available, size of pipe, and invert and outlet elevations of all drains landside and waterside of the levee(s). Obtain and populate all attributes required as indicated in the data dictionary as field collected in the database such as type of pipe, etc. Note: sill elevations may or may not be the invert elevations. Collect photos of features where possible. (gravity_drain_line)

6.2.5. Locate all Pump Stations, obtain point feature coordinates and ground elevations as well as applicable attribution, i.e. pipe size, number, material, etc. Collect photograph of pumping apparatus. (pump_station_point)

6.2.6. Collect point locations of visible levee stationing markers on or near the levee, floodwall, or closure structure alignment. (levee_station_point)

6.2.7. Locate the elevations and locations of all National Geodetic Survey (NGS) and US Army Corps of Engineers (USACE) vertical and horizontal control found along the levee and provide a report of the condition of the monument. The Army Corps of Engineers Monument Archival and Retrieval Tool (USMART) should be used in discovery process of any existing control for the levee project.

6.2.8. Project Benchmarks and Control Points. All control points or benchmarks used in the collection of features for this project shall be tied to points in the NSRS database. Control points, benchmarks, and gage stations (benchmarks) used for previous design, construction, or as-built surveys and listed on existing drawings shall be tied in to the NSRS database. A minimum of one (1) permanent benchmark / control point shall be required for all projects less than 15 miles in length. Generally, the control monument should be within five miles of the levee unit. If the project lengths are greater than 15 miles then additional benchmarks / control points are to be incorporated as described in the Comprehensive Evaluation of Vertical Datums (CEPD) technical guidance dated April 2, 2007, appendix B. The intent of this requirement is to ensure that all levee surveys are tied back to NGS control. Setting of new monuments is not required except in situations where existing NGS control is unavailable. The survey team is encouraged to document, as part of the proposal, the number of monuments expected to be set for the proposed price, so that varying site conditions can be documented if they are encountered. Benchmarks shall be established, thoroughly described, photographed, and referenced. All vertical control must originate from the approved NGS monument(s), unless other approval is obtained. The control report will be of what control the vertical elevations have been established from. Any permanent benchmarks or control points established or reestablished are to follow the latest CEPD guidance/NOAA NGS guidelines. All control points or benchmarks listed in the deliverables shall be clearly marked with the datum and epoch designations (e.g. lat, long (NAD83 (2011), elevation (NAVD88 (GEOID12A)).

6.3 Levee Data Gathered in Other Processes

The following NLD information will be captured during secondary or follow-on processes that are not part of the initial survey requirement.

6.3.1 Flood fight related information (sand boils, floodfight points, etc) will be gathered in a separate process and will involve coordination with the Emergency Management community.

6.3.2 Levee Inspection data is not gathered as part of the initial survey and would be covered during any periodic or routine inspections.

6.3.3 Additional levee stationing beyond any visible markers will be compiled separately using project design and operations and maintenance documentation.

7.0 Leveed Area Delineation

A final step in the data population procedure involves the development of a leveed area polygon feature class. In the majority of cases the leveed area is an area behind the levee or floodwall, using minimum top of levee elevation projected out to the corresponding elevation contour behind the feature. Protected areas that may encounter overland flow conditions behind the levee will have to be manually developed by a GIS analyst and Hydraulic Engineer to ensure the proper area is represented. No ground surveying is required for this step and the data can be compiled using standard desktop geospatial analysis software and the best available elevation model for the area behind the levee.

8.0 Deliverables

The data gathered as part of the ground survey and attribute collection phases should be compiled into a NLD schema geodatabase (most recent version) following the rules in section 4.0. The minimally required attributes must be present for submission but the additional attributes are encouraged to be populated based on time and money constraints for the survey.

All deliverables shall be in electronic format and provided on Mass Storage Devices (non-flash).

- NLD geodatabase(s) with standard entities populated as defined by the NLD Data Dictionary, and feature class level metadata for all populated entities completed in accordance with the FGDC Metadata Template.
- All Ground Control Points (GCP) and other field data collected for this project, in appropriate formats and documentation – to be refined when more is known about field data collection methods.
- A detailed report for each levee (project), prepared by a licensed professional engineer or surveyor, with current registration in the respective State, listing of all coordinates and elevations of points as identified above, fully describing surveying methods and procedures used. The report shall be provided in PDF format and include standard metadata that is ISO 19115 or FGDC compliant.
- All original field books, raw and processed GPS data, showing level loops and horizontal control networks, and reference monuments as well as all other information as required in paragraph 3 above. Recovery notes, sketches and written descriptions of each of the control points shall be provided to the Government. The original field books shall contain the coordinate value, in pencil, for each point on the page with the sketch for that point provided in PDF format.
- Any additional survey control (eg. NGS, USGS, USC&G, DOT or local District) that may have been discovered and/or utilized during the survey.

- A report detailing vectors and adjustments for GPS coordinates for any GPS derived coordinates and/or elevations obtained.

9.0 Quality Assurance / Quality Control Guidance

In-house surveys should follow standard internal quality procedures as established by each district for surveying. If contract deliverables are involved, a government quality assurance plan is required for the contracted scope. Quality control plans for contracted scope should include at a minimum checks on data completeness, topology and spatial accuracy. Quality assurance and quality control summary reports should be included throughout the survey process up to NLD deliverable completion.

10.0 Referenced Documents

IPET 2006

“Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System,” Draft Final Report of the Interagency Performance Evaluation Task Force, US Army Corps of Engineers, 1 June 2006. (Volume II--“Geodetic Vertical and Water Level Datums”) <https://ipet.wes.army.mil>.

EC 1110-2-6065

Engineering and Design - Comprehensive Evaluation of Project Datums: Guidance for a Comprehensive Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects, 1 July 2007.